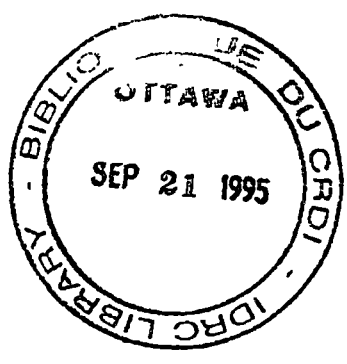
TRAINING STUDY

BOLIVIAN CASE

Bogotá, D.E., July, 1980



NATIONAL OVERVIEW

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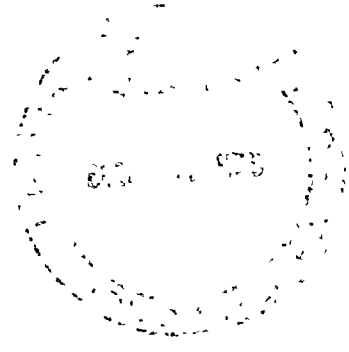

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METHODOLOGY

Two methods were used to produce the overview on Bolivia: (A) Analysis of existing documentation and (B) interviews. These latter were of two types: personal or individual-institutional.

A. Analysis of Existing Documentation - General Considerations

The documents to be subsequently detailed constitute an important information-providing basis for the national overview. These are:

a. National Academy of Sciences, National Council of Higher Learning. "II National Symposium on Science and Technology", La Paz, November 13-16, 1975.

b. Ibero-American Cooperation Centre, "Bolivian National Report" submitted by Dr. Ovidio Suárez to the First Ibero-American Meeting on Science and Technology, Vol. I, Madrid, January 29-31, 1979.

c. Directorate of Science and Technology, Ministry of Planning and Coordination, "Monograph of the Republic of Bolivia" submitted to the United Nations Conference on Science and Technology for Development. Viena, August 20-31, 1979.

d. Directorate of Science and Technology, Ministry of Planning and Coordination, "Activity Report", La Paz, Bolivia, 1978.

e. Ministry of Planning and Coordination, "First Basic Plan for Scientific and Technological Development", Draft for Internal Discussion, s.d.

f. Ministry of Planning, "Bases and General Policy Lines on Science and Technology", 1980 Operational Plan, Draft, La Paz, October, 1979.

g. Supreme Decree No. 15111 establishing the National System for Scientific and Technological Development (SINDECYT). 1977.

h. Commission for the Integration of Services of the Educational Sector - COMISEN. "National Educational System: A Project", Fourth Part, Chapter Ninth: Research and Graduate Training, La Paz, January, 1978.

i. Ponce Sanjinés, Carlos and Marta A. Suatetz, Scientific Research in Bolivia, Vols. 1 and 3, La Paz, 1975.

j. Cisneros, J. Antonio, "A Diagnosis of the Scientific Potential of Bolivia", Centre for Social Research, June, 1978.

A couple of notes are necessary on some of the documents just listed:

1. The nature of working documents and discussion drafts must be stressed in the case of the documents relative to the First Plan for Scientific and Technological Development (e) and to the Bases and General Policy Lines on Science and Technology (f). They were not officially approved and inasmuch as they do not constitute government papers they have not been formally included in the national development plans. Nevertheless, it must be noted, the policy guidelines and the priority areas defined in those documents constitute de facto work parameters for the Directorate of Science and Technology, a branch of the Ministry of Planning and Coordination.

2. In reference to the documents on scientific research in Bolivia (i) and a diagnosis of the scientific potential of Bolivia (j) the following considerations are required:

   - The former is based upon an inventory of the country's scientific and technological potential conducted under the auspices of the Organization of American States in 1974. Because of the methodology used in it, a confusion prevails between institutions effectively engaged in research and those just potentially engaged in it. Likewise, research activities as a whole appear mixed up with support activities to research and coordination of it. In view of it, the data on numbers of research institutions and research projects as well as on human and financial resources are considerably overestimated. It is also necessary to point out that the authors of the former study admit the limitations mentioned here.

   - The latter document overcame the deficiency of the former in that it clearly distinguished between active and potential research institutions as well as between both of them and those of a support and coordination nature. Thus, at a general level, it has a closer sense of reality than the previous document. Instead, when it comes to specifying numbers of researchers, amount of financial resources and research training activities, the study is limited to data from just

slightly more than 40% of the pertinent institutions. However, in the absence of broader and stronger information, the statistics used for this national overview come from this second document, which although is not a complete one it conveys data on a representative sample.

B. Interviews

1. Personal Interviews

These were conducted with selected scientists whose outstanding knowledge of the country's scientific activity made them valuable sources of information and opinion without committing the institutions for which they work. Those persons were:

a. Carlos Aguirre, a Bolivian expert who had recently joined the Andean Pact's Group on Technological Policy (Lima, Peru).

b. Carlos Brockmann, prominent researcher in charge of the satellite prōgram (resource detection) of the National Geological Service, a branch of the Ministry of Mines.

c. Armando Cardozo, an animal husbandry specialist who directs a regional rural development program.

2. Individual-Institutional Interviews

These were conducted with respondents who, in spite of reacting to the questionnaire on an individual way, were speaking for their institutions as these were directly concerned either with the conducting of research and the training for it. Those individuals were:

a. Ramón Schulczewski, Directorate of Science and Technology, Ministry of Planning and Coordination.

b. Gastón Mejía, National Academy of Science.

c. Enrique Mendizábal, Division of International Cooperation and Scholarships, Ministry of Planning and Coordination.

d. Enrique Velasco, Executive Committee of the Bolivian University.

I. NATURE OF THE SCIENTIFIC CAPACITY

1. Brief Considerations on the History of Research

Some observations on the evolution of the research activity are required in order to understand Bolivia's present ability to conduct research. According to the conclusions of the II Symposium on Science and Technology organized by the National Academy of Science 1/, it is felt that, in the case of seven sectors 2/, "... until some 15 years ago (1960) research took place, in general, in an isolated and uncoordinated manner, usually without planning inasmuch as given guidelines required by the country's development needs were not taken into consideration". Said document adds later: "It is also apparent that in the past there was a lack of integration in research, which resulted in isolated efforts or in mere attempts at doing research". As a part of such efforts, a few important endeavours did take place in some of the sciences -- the natural sciences in particular. Thus, it is worth noting the long-standing activity of the Chacaltaya Laboratory of Cosmic Physics. This pioneer scientific institute has for years conducted significant research and has given origen to other scientific institutions, several of which were either strengthened or established in the 1960 decade.

Research on agriculture and animal husbandry begins in 1945 under the leadership of the Inter-American Agricultural Service (SAI), a cooperation agency jointly sponsored by the Bolivian and U.S.A. governments. This impulse declined as of 1965, when the agency was fully absorbed by the Ministry of Agriculture and Peasant Affairs. In the decade of 1970, new cooperation arrangements between the two governments determined the creation of the Bolivian Institute of Agricultural Technology (IBTA), which seeks to revive the sector's research activity along with extension work.

1/ National Academy of Sciences and National Council on Higher Learning, "II National Symposium on Science and Technology", La Paz, November 13-16, 1975.

2/ The seven sectors are: Health Sciences; Exact and Natural Sciences; Architecture and Arts; Transformation and Production of Renewable Resources; Humanities; Agricultural Science and Technology; and Social Sciences-Education.

The National Academy of Sciences was established in 1960 as a decentralized agency of the Ministry of Education and Culture, and was placed in charge of policy formulation for the development of activities in science and technology. The institution was unable to properly fulfill this mandate until 1977 due to reasons as the following:

a. The Academy was hardly connected with the State in general

b. Being an autonomous agency, the Academy did not form part of the National Planning System. Therefore, it represented a scientific community only very loosely related to the nation's aims, plans and actions for overall development.

c. The Academy lacked adequate financial support and thus was not endowed with means to perform its ambitious goals.

It was only in September 1977 that the government, through the Supreme Decree No. 15.111, established the National System for Scientific and Technological Development (SINDECYT), within which the Directorate of Science and Technology was established at the Ministry of Planning and Coordination. The goals, structure and policies of this latter will be described later in this report.

It must be noted that, prior to the establishment of SINDECYT, the Major University of Saint Andrews (UMSA) had already created just for itself a Planning and Coordination Centre for Scientific and Technological Research (CEPIC). Although the decision to create CEPIC was made in 1973, its actual and final implementation happened only in 1976 and by 1979 the organization had ceased to exist to be replaced by the University Commission on Research. 1/

In spite of attempts at research planning, such as those conducted upon the establishment of the Academy of Sciences and of SINDECYT, some of the problems described still prevail. For instance, in some sectors, such as that of the exact and natural sciences, a lack of coordination still affects research. In fields such as chemical technology research is still

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1/ This section will be further developed in this report when referring specifically to the UMSA's Research System.

very deficient. In a number of sectors some research ventures are still conducted without a prior sharp definition of goals. Some of the main reasons for such a situation will be discussed further along the present report.

2. Institutional Resources of the Scientific and Technological System 1/

In the document already referred to here 2/ 302 institutions were identified as performing science and technology tasks in the country. They are divided in three subcategories:

a. Research Institutions - Those whose activities on scientific inquiry involve at least 90 of their energy, time and resources. Of this type 109 institutions were found.

b. Potential Research Institutions - Those in which scientific inquiry represents only 10% or less of the total activity but whose staffing and other conditions indicate a clear possibility for expansion of research. Of this type 156 institutions were found.

c. Coordination and Support Institutions - Those which are not in the business of conducting research as such, but in helping in one way or another, others do it. Of this type 37 institutions were found.

From the 109 institutions essentially devoted to research, the majority belong to the agricultural sector. This is mostly explained by the existence of several field experiment stations. Next in turn are the health research agencies and the third place is occupied by social science research institutes. The institutions dedicated to physical-natural science research and those devoted to humanities share a low position in this scale, followed by engineering research institutions. And the lowest place goes to institutions doing research on fine arts, as can be seen in Table 1.

1/ The study of J. Antonio Cisneros "Diagnosis of Bolivia's Scientific Potential", Centre for Social Research, June 1978, was taken as the basis for analysis of the science and technology system's resources as well as for that of human resources and training in the research institutions.

2/ Ibidem.

Table No. 1

Number of Institutions and Distribution by Scientific Activy Areas

Areas	No. of Institutions	Distribution (%)
Physical and natural	15	13.8
Engineering & development	10	9.2
Health sciences	20	18.4
Agricultural sciences	27	24.8
Social sciences	18	16.5
Humanities	15	13.8
Fine arts	4	3.7
TOTAL	109	100.0

3. Human Resources Devoted to Research Activity

As has already been noted, the study used here as a basis 1/ has made an inventory of the institutional, human and financial resources working with a sample of 47 institutions from the country's total research agencies. In the case of human resources, instead, the study provides an estimate for the universe of 109 institutions. Reference will be made here first to the sample just mentioned and later to the overall estimate for the universe.

In terms of number of scientists available by areas of science, the highest position is occupied by the physical and natural sciences, which have the longest tradition on research activity in the nation. They are followed

1/ Cisneros, J. Antonio, Op. cit.

at a very considerable distance by the agricultural and engineering areas. The area of social sciences shows an even lower but relatively important level while the humanities and fine art areas share the bottom of the scale, as can be seen from Table 2.

Table No. 2

Number of Scientists by Science Areas

Scientific Areas	No. of Scientists	Distribution (%)
Physical and natural	165	38.5
Engineering & development	67	15.6
Health sciences	36	8.4
Agricultural sciences	85	19.8
Social sciences	59	13.8
Humanities	11	2.6
Fine arts	6	1.4
TOTAL	429	100.0

It must be noted that, as reported in the document just referred to, the scientific personnel constitutes 30.5% of the total staff employed by the institutions included in the sample. Of the balance, 19.8% corresponds to auxiliary technical personnel and the remaining 49% corresponds to administrative staff.

The total number of scientists computed by Cisneros for the 47 institution sample was, in principle, of 429. However, he added to it estimates corresponding to the probably size of staff in the rest of the institutions

up to the total of 109. 1/ He arrived in this manner to a final total of 610. Both sets of figures are presented in Table 3.

4. Financial Resources

The author of the referred sample study found considerable difficulty in getting data on the economic aspects of the operations of the sample of 47 institutions analyzed. Thus, he was only able to obtain some very general indicators providing an idea of the financial resources available in general to the institutions and especially of those directly allotted to the conduct of research by them.

a. Overall budget of research institutions

Institutions were distributed along three annual budget categories: under one million of Bolivian pesos (US$1.00 = b$20.00), between one and three million, and more than three million.

The highest number of institutions in the 1-3 million and more than three million brackets corresponded to physical-natural science institutions, followed at appreciable distance by the engineering institutions. Health and social sciences institutions were concentrated on the 1-3 million category. Instead, agricultural institutions, though being high in number were not so in yearly expenditures if taken individually; in fact, except for one, every other fell in the category of less than a million. Finally, institutions concerned with the humanities occupied the extremes of the range while those of fine arts were located on the inferior brackets, as Table 4 shows.

1/ For each area of science, he took into consideration the percentage that the institutions in the 47 samples represented the universe of 109 institutions. He then applied these percentages to the number of scientists in the sample for each area. This gave him the probable difference which he finally aggregated to the original total. For instance, in the area of the physical-natural sciences, the institutions in the sample were 12, whereas the total of them in the universe was of 15. That is, the sampled institutions represented 80% of the overall total of institutions in said area. Cisneros then assumed that the resulting 165 scientists for the area also constituted the 80%. The balance of 20% gave him in the case a figure of 33 scientists, which he added to the 165 to finally come up to 198 for the area.

Table No. 3

Distribution of Institutions by Sectors and Number of Scientists for Sample and Universe

SECTORS	No. of Scientists from sample	Estimated number of scientists	Total scientists	Total agric. institutions from sample	Total research institutions	Representative %	Compensation %
Physical and natural	165	33	198	12	15	80.0	20.0
Engineering and development	67	33	100	5	10	50.0	50.0
Health	36	27	63	5	20	25.0	75.0
Agriculture	85	47	132	12	27	44.5	55.6
Social	59	29	88	9	18	50.0	50.0
Humanities	11	9	20	2	15	13.3	86.7
Fine arts	6	3	9	2	4	50.0	50.0
TOTAL	429	243	610	47	109	43.1	56.9

Table No. 4

Number of Institutions by Activy Sector and Budget Range

Scientific Areas	BUDGET RANGES			TOTAL (1)
	Under one million b$*	Between one &3 million b$*	More than 3 million b$*	
Physical and natural	2	5	5	12
Engineering & development	1	2	2	5
Health sciences	-	4	1	5
Agricultural sciences	11	1	-	12
Social sciences	2	6	1	9
Humanities	1	-	1	2
Fine arts	1	1	-	2
TOTAL	18	19	10	47

* Bolivian Pesos $20.oo = US$1.oo

(1) Refers to the total number of institutions

b. Financial resources for personnel cost

It was also important to try and distinguish between the costs of the staff and the rest of the institutional expenditures. The data on this question lead to concluding that, out of the 47 institutions surveyed, 31 devoted to personnel costs more than 70% of their total budget. This is seen from Table 5.

c. Summary appraisal of the financial situation

The main conclusion derived from analysis of this situation is that personnel costs consume at least two thirds of the funds, while the remaining third goes to operational costs, including administration, investments and research.

Table No. 5

Number of Institutions by Area of Science and Personnel Expenses by Ranges, Within the Budget

Scientific Areas	Personnel Expenditure Levels - Budget			TOTAL (1)
	More than 70%	Between 50 and 70%	Less than 50%	
Physical and natural	6	3	3	12
Engineering & development	2	1	2	5
Health sciences	4	1	-	5
Agricultural sciences	9	3	-	12
Social sciences	6	1	2	9
Humanities	2	-	-	2
Fine arts	2	-	-	2
TOTAL	31	9	7	47

(1) Refers to the total number of institutions

Is this plausible? The Bolivian respondents think it healthy since they equate personnel expenditures with "technical" costs and operational expenditures with "administrative" costs, except for those in the category of "research". Given the proportions, however, there is room for doubt. Too much money for researchers and too little money for research may suggest the perfil of bureaucratization. That is, the country may have a significant number of scientists not endowed with sufficient money to conduct studies. If so, at least in some situations, having jobs may end up taking precedence over obtaining knowledge.

5. Research Activities of the Selected Institutions

Their activities are conducted under diverse operational labels. Namely:

a. Basic research

b. Applied research

c. Experimental development research

d. Diffusion

e. Training, covering formal and non-formal tasks taken as elements of the research endeavours

f. Allied, which involves assorted tasks such as leadership and management in research.

To which degree do institutions in each area of science perform which of those types of research activities? These are some possible answers:

a. In the case of the physical-natural sciences, applied research is the main activity, followed by basic research. Next come training and the rest of activities are relegated to a low level of intensity.

b. In the case of the exact sciences (essentially engineering), applied research also comes first and basic research second. Next come diffusion and experimental development while training and allied activities are relegated to a low level.

c. In the case of health sciences, the same priorities on applied and basic research prevail, followed by diffusion. The rest is relegated.

d. In the case of agricultural sciences, applied research is the dominating category and training is not performed.

e. In the case of the social sciences, applied research is the chief category, followed by diffusion and training.

f. In the case of the humanities, applied research and diffusion occupy the same main level while training is lower.

g. In the case of the fine arts, basic and applied research as well as diffusion and training share the same location.

In summary, as a rule, the scaling of activities is the following: (1) applied research, (2) basic research, (3) diffusion, (4) training, and (5) the so called allied activities. Table 7 provides details on this topic.

Table No. 6

Porcentual Participation in Different Actions Within Institutional Total

Activities by Areas of Science

	Physical & Natu.	Exact Not Renew.	Health	Agri-culture	Social	Human-ities	Fine Arts	Total
Basic research	21.4	25.0	30.8	5.6	-	-	25.0	16.4
Applied research	26.2	31.3	38.5	66.7	44.4	40.0	25.0	37.9
Experimental development	11.9	12.5	-	11.1	5.6	-	-	8.6
Diffusion	16.7	18.8	15.4	16.7	22.2	40.0	25.0	19.0
Training	21.4	6.3	7.7	-	16.7	20.0	25.0	13.8
Allied	2.4	6.3	7.7	-	11.1	-	-	4.3
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Cisneros, J. Antonio. Op. Cit. The calculations were based on the data in Chart No. 6 of that study.

II. DEMAND AND SUPPLY OF RESEARCH PROFESSIONALS

No study is available in Bolivia on the demand on supply of scientists. In the absence of it, scarcity or abundance of them cannot be objectively determined, especially not by areas of science.

The interviews conducted for the present report did provide, however, some clues on the matter. For instance:

1. In general, the Ph.D. level of scientists seems to be the least endowed in Bolivia. The country does not offer graduate training in any field yet. And most of the few Bolivians who manage to obtain such degree tend to work outside their country due to the lack of attractive remunerations and acceptable resources and facilities to conduct research prevailing in it.

2. There is, in general, scarcity of trained researchers rather than abundance. This deficiency would seem to be particularly acute in certain areas to which the scientific activity is addressed, such as the following:

   - Agriculture (especially, soils)
   - Natural resources (prospection use, conservation and renewal)
   - Ecology in general
   - Pure and natural sciences
   - Basic chemistry and mathematics
   - Mineralogy
   - Health sciences, chiefly in physiology, communicable diseases, and basic biology.

III. SCIENTIFIC AND TECHNOLOGICAL POLICY, PROGRAMS AND PRIORITIES 1/

As has already been said, Bolivia does not have yet an officially approved National Plan for Scientific and Technological Development, but the existing working documents are being used, in practice, as sources of guidance for action by the Directorate of Science and Technology at the Ministry of Planning and Coordination. Furthermore, the policies, programs and priorities recommended in those draft documents are coincident in every aspect with the official document submitted by Bolivia to the United Nations Conference on Science and Technology.

1/ This section is essentially based upon this document: "Ministry of Planning and Coordination", First Basic Plan for Scientific and Technological Development, Draft for internal discussion.

1. General Guidelines for the Scientific and Technological Policy

The scientific and technological policy bases in existence are in line with the country's overall strategy for national development. They seek to fit, that is, the requirements and orientations of the 1976-80 Plan for Economic and Social Development. This official statement acknowledges science and technology as a fundamental instrument for said development. A further recognition of that importance is given by the establishment of the National Scientific and Technological System. 1/

The expansion and refinement of human resources and the provision of financial assistance (from national and foreign sources) to the research activity are the basic postulates for the attainment of scientific and technological development in Bolivia. There are two related guidelines. First, support must be granted to research projects marked as prioritary for the country's development in the national development plans. Second, research should also be flexible concerned with other avenues of inquiry, such as those for which the country is particularly suited - i.e., geology, mineralogy, solar energy, etc. - because of the nature of its geography. Third, a pragmatic but not rigid approach to development-related priorities is desirable in the utilitarian terms of short-term obtention of certain data. Of no less importance, however, is the ability to conduct innovative research and fundamental research which, although of a looser nature and longer duration, may make Bolivia a contributor to the world pool of scientific knowledge.

2. Priorities and Programs

The science and technology priorities by sectors deemed required for the 1976-80 period were as follows:

Agriculture - First priority. This is justified by the need to overcome one day the country's undesirable dependence upon mining, an extractive industry which has several limitations and fails to offer the potential that agriculture offers. A country with only 5 million inhabitants for a territory almost as large as that of Colombia, Bolivia should be able not only to fully serve its own internal food and fiber needs but also generate a sizeable surplus for earning income from farm exports. To this end, the draft plans provide agricultural research policy guidelines as the following:

1/ The structure of this system is depicted in Annex 1.

a. Research must emphasize the study of activities seeking to increase agricultural productivity, especially in the areas of foodstuff to meet the national demand and raw materials.

b. Research must also help gain learning about the rational exploitation of the agricultural natural resources, along with the special development of those not too well known yet, like some in the highlands.

c. Research should also assist the process of transfer of technologies to rural producers.

d. Research should favor agrochemistry studies, especially in relation to fertilizers and pesticides.

Mining - Second priority. This sector generates 58% of the foreign earnings and presently constitutes the basis of the national economy. Research should concentrate on:

a. Helping find new mineral sources.

b. Helping improve the methods of exploitation and treatment of minerals.

c. Converting the export product from mineral to melted metal.

d. Helping shift the mining exports from mineral to melted metal and semi-processed articles.

Energy - Priorities in this area go to research on hydrocarbons and petrochemical industry, expansion of the hydroelectrical capacity, and identification of non-conventional energy sources.

Health - Research priorities for this sector go to food and nutrition problems along with mother-and-infant protection.

Education - Priority goes in this case to problems of the basic education and illiteracy since about one half of the population is not a native speaker of Spanish. On the other hand, research addressed at helping improve higher learning programs, including those devoted to training scientists, is also given priority.

Infrastructure - Research assistance is invited to problems of lack of an adequate vinculation among the different major regions of the nation, of relocating population, and of establishing new industries, as well as to transportation and communications needs.

Other sectors - Under technology for regional and social development, research is deemed desirable on environmental problems on sanitation and housing, and on integrated regional development programs.

3. Budgetary Considerations

The basic source of funding for research activities has been the State through several sector budgets. There hardly is any private investment in activities of scientific inquiry.

Exactly how much money goes to research as such is something which up to now has remained undefined. A precise quantification is not possible because research does not constitute a specific category in the overall national budget. To build such a category into the financial programming of the State requires the formal establishment of the national plan of science and technology for development. Meanwhile, the cost of scientific inquiry cannot be strictly told apart in Bolivia.

IV. THE TRAINING OF HUMAN RESOURCES

The following considerations are in order on this topic:

1. Bolivia does give an important role to training of human resources within the design of its Science and Technology System.

2. So far, however, such activity has not responded to an official planning policy either in terms of areas of specialization or in those os academic level. It is not ruled, that is, by any rational and systematic coinciliation of demand and supply.

The country has legal regulations by which all foreign offer of scholarships should be channeled through the Scholarship Department of the Ministry of Planning and Coordination. However, some donor agencies - namely, AID - distribute their scholarships directly to persons and agencies without concern for said regulations. But even the distribution of those scholarships processed through the above mentioned office tend to serve more individual needs than institutional requirements.

3. There is not an overall training policy for the country's development. In the absence of it, the use of both foreign and national funds to cover the training costs tend to be, for the most part, erratic and fails to fit with the priorities of the national development plans. Relatedly, while some foreign donors supply rather abundant training opportunities in areas of little interest to the government, other pressing training needs fall outside their scholarship programs.

4. There are no graduate training programs in the country in any field or scientific discipline. Bolivians must go abroad to obtain Master's and Ph.D. degrees. This is slow and expensive and often ends up in the graduates remaining abroad for lack of attractive opportunities to return home. Occasionally is a part of the activities of the several university research institutes existing, graduate-level courses are conducted on a short-term and non-degree basis. While this is useful, it evidently does not compensate for the lack of regular and long-term graduate programs through which very many scientists could be trained in situ, at lower costs and without the danger of alienation or "brain drain".

Therefore, the establishment of graduate training programs is regarded an urgent need in Bolivia. Careful consideration has to be given to which disciplines justify such an effort in terms of the countries' needs and possibilities. The availability of high level native professors and the level of potential student demand are crucial factors in making decisions in this area.

As pointed out in a study 1/, the need for in situ graduate training is quite evident in areas such as the pure and natural sciences, the health sciences and some of the fields of technology. In certain areas, such as health itself and economy, Bolivia has a sufficient body of high level professionals capable of conducting graduate training programs. In other areas, such as agriculture and the natural and exact sciences, there seems not to be available yet a sufficient number of adequate potential professors but the institutional infrastructure for the program's conduct does exist, especially in the case of the Major University of Saint Andrews, of La Paz. Thus, perhaps in some cases long-term foreign professors could start the programs while top local scientists go abroad to get their superior degree and return to take over their teaching duties.

1/ COMISEN. "National Educational System-Project", La Paz, January, 1978.

V. DEMAND PROJECTIONS ON HUMAN RESOURCES FOR RESEARCH

It is not possible to define whether the country may be able to satisfy the demand for the training of scientists in the coming years. As mentioned already, there is not available a training demand-supply study. The planning unit of the Executive Committee of the Bolivian University has accumulated some useful data in this respect but a formal inventory seems still long away in the horizon.

VI. GENERAL CONSIDERATIONS ON TRAINING

1. Needs by Areas

In the draft for the First Basic Plan of Scientific and Technological Development, special attention is recommended in favor of these fields:

- Natural and exact sciences, with an emphasis on mathematics, computing, physics, astronomy, chemistry, geology and ecology.
- Health sciences.
- Engineering sciences.
- Agricultural sciences, with an emphasis on education, economy and administration.
- Urban development.

One of the areas in which the lack of sufficient training appears especially acute in Bolivia is that of development, conservation and proper use of natural resources. This leads to proposing a high priority for the training of scientists in the environmental and ecological fields. Likewise, much training is urgently needed in the energy field, especially in terms of exploting new energetic options as well as in those of an intensified use of some conventional sources, such as hydroelectric power. A third area of acute insufficiency is that of mineralogy, a clear need in a country which earns its livelihood from mining. Most universities have concentrated on metalurgy to the neglect of mineralogy, which is served only by one State research institute.

Finally, it must be noted that it is the basic sciences, both the pure and natural, the ones confronting the most serious limitations in the training of human resources. The possible excertion is geology, for

which the country has been able to train already a significant number of professionals.

2. Location of Training

As has been noted already, the absence of graduate training facilities in the country determines that those wishing to study at that level must go abroad. This often is not ideal and hence the urgent need to establish locally graduate training programs at least in some disciplines. In certain other disciplines, instead, Bolivians will still have to go abroad to get their training in highly developed countries. And, in the case of less specialized studies what would appear most desirable is an intermediate location: neither within the country nor in the highly developed ones, but in countries somewhat more developed than Bolivia and yet comparable to it in culture. This would reduce re-entry adaptation problems very considerably.

In any case, wherever the graduate training might take place, the research studies leading to the obtaining of degrees, should be conducted on matters of the Bolivian reality and, whenever possible, be done in the country itself.

3. Type of Training

A four-level scaling is deemed desirable in the training of scientists:

a. Initial training (trhough practice of elementary research work).

b. Graduate level courses.

c. Post-Doctoral independent work.

d. Short term polishing and up-dating short periods, such as lecturing, simposia, professional congresses and assistance.

VII. OBSTACLES TO THE DEVELOPMENT OF RESEARCH ACTIVITIES

In the document of the National Academy of Sciences 1/ the main barriers research has to overcome in Bolivia are listed as follows:

1/ National Academy of Sciences - National Council on Higher Learning, "II National Symposium on Science and Technology", La Paz, November 13-16, 1975.

1. The lack of planning on a national scale.

2. The scarcity of funds for the conduct of research projects and for training in research.

3. Lack of consciousness on the part of decision-makers on matters of public interest about the importance of research as instrument to facilitate national development.

4. Lack of salary incentives for researchers.

5. Deficiencies of infrastructure, especially equipment.

6. Lack of stability of the scientific personnel in State or University jobs, which are often negatively affected by political influences that impede the continuity indispensable in scientific work.

7. Migration of human resources to other countries offering much more attractive remunerations, job stability, and facilities of work.

8. The blind adoption of technological packages coming from abroad.

To all these barriers an increasing lack of time is added in the case of many of the scientists employed by the universities, public or private. Since the student population grows rapidly without a commensurate growth in the teaching staff, professors are soon overloaded with teaching obligations that prevent them from doing research, save for occasional exceptions. The consequences of this problem are very serious since at least two thirds of all research in the nation is conducted by university scientists.

VIII. THE ROLE OF INTERNATIONAL ORGANIZATIONS

Bolivians feel that foreign assistance to their research endeavours is most desirable and useful. Up to now it has come basically in the form of scholarships for Bolivians to get scientific training abroad. Occasionally, it has also come in the form of resident foreign experts who have come to teach, advise and do research in Bolivia. Rarely ever has it come also in the form of equipment grants to institutions enabling the graduates to improve their research activity after the training abroad. This latter form of aid is deemed vital, especially in the physical and natural sciences.

In the absence of adequate equipment, many former trainings are rendered unable to do an optimal application of what they learn in other lands. Some get quite frustrated and tend to leave the job, the field or even the country. It, thus, would be very desirable that foreign assistance to research in Bolivia came in a "package" format, containing all three elements: scholarships abroad, equipment grant, and expatriate researchers. Each component would secure and optimize the investment made on the other element of the package.

Bolivians do perceive that such a treatment of foreign aid could not be done to a significant volume to cater to all needs. But they feel that two things would help the strategy. On the one hand, to have the several international agencies combine their inputs to research training in Bolivia, and, if needs be, make a distribution of institutions and disciplines to be assisted by each. On the other hand, perhaps reduce the level of scholarship donation while increasing the level of equipment endowement and keeping low and transitory the level of resident experts so that they are not taken as permanent substitutes of national scientific talent.

From another perspective, external assistance to the design and operation of in-country graduate training programs is regarded also as a very desirable role in Bolivia for institutions as IDRC.

IX. MIGRATION OF SCIENTISTS

The set of problems listed above, coupled with the fact that all graduate training is available only away from Bolivia, determines that many highly trained Bolivian researchers be lost. A few move from the jobs in which they were when receiving a scholarship to another comparable but better paid research position in the country. Some leave the research activity altogether and, although they stay in the country, they join private firms where their talent and energy can turn more profitable. And although at the price of deviation, others yet either do not return to Bolivia at all from abroad or go back to other countries not too long after having returned to Bolivia. This problem of "brain drain" may be less acute in Bolivia than in countries as Colombia, but it is more grave in Bolivia where replacement of researchers is very difficult because of the very limited availability of them.

SUMMARY

Bolivia is located in the middle of the Southern region of Latin America, linking with Chile, Peru, Brazil, Argentina and Paraguay. Although its territory is practically as large as that of Colombia, its population hardly surpasses the 5 million figure and at least one half of it is made of non-Spanish speaking peasants sunk in grave poverty, isolation and ignorance. One of the main exporters of tin in the world, the country earns most of its livelihood from selling minerals abroad. Traditionally, it has suffered from much political instability. Standard indicators of underdevelopment place the country among those in the very low level of advancement.

Science has so far played a modest role in Bolivia. There are slightly over 100 institutions fully and continously devoted to conducting applied and basic research. Most of them lie in the autonomous university domain, followed by those within the government; there virtually is no private research of significance as the country's industrial system is quite incipient still.

A total of some 600 scientists fully devoted to research were identified in the nation. At least one third of them is employed by institutions doing research in the physical and natural sciences. Second, as scientist employers come agriculture, engineering and the social sciences. Health sciences, humanities and fine art institutions employ very small numbers of researchers.

Consciousness of the importance of research for development purposes is still very weak. As a consequence neither the State provides the research community with sufficient incentives and support to expand and refine the scientific inquiry nor does this community show to be too eager to fit its academic endeavours with the nation's requirements. Although there are no reliable basis yet to find out how much money the country spends in research, there are clear indications that it cannot be very much. Universities are the main researchers in Bolivia and they spend some 70% of their research budgets paying their scientists' salaries, thus leaving the balance to foot operational costs.

Bolivia has had for long overall strategies for national development, from which yearly action plans are derived. Although it has legally established a "National System of Science and Technology", the country does not have yet a national policy for scientific and technological development, or yearly research plans. Draft blueprints do exist, however, and seem to already provide de facto guidance to the Directorate of Science and Technology, at the Ministry of Planning, and to the National Academy of Science, an association supported by

the Ministry of Education and Culture. In general, it is understood that research must follow closely the priorities established by the national development strategy, which - for instance - plays up agriculture and mining-metallurgy. In particular, the universities are struggling to rationalize and coordinate the activities of their diverse research-conducting bodies.

There is consensus in Bolivia about the decisive importance of training scientists and full agreement that foreign aid is required to support it. Researchers are lacking in virtually every development-related activity but their scarcity is especially acute in some cases. For instance, those of the exact and natural sciences, of health sciences and of agricultural sciences. New areas, such as ecology and non-conventional energy, are among those showing pressing training demands. But well established areas such as mineralogy and the conservation and proper use of natural resources are also sorely lacking in competent personnel.

High level and long term training of Bolivian scientists takes place, so far, only abroad. There is no graduate training in the country in any field or discipline. And lacking are also a policy for the training of scientists and a study of training demand-supply by development sectors and scientific areas. In the absence of them, few scholarships go to the training of professionals to do research. Moreover, of those which do go to them, most are assigned on a personal basis rather than seeking to fit institutional requirements as related to national development priorities.

Some of the graduates trained abroad never return to the country. Others return but leave for other countries again as soon as they can afford to. Of those who stay, some leave their original institutions but remain devoted to research elsewhere. But others just leave the field altogether to join more remunerative activities. The main reasons for such desertion are the following: very low salaries, lack of stability due to political factors, lack of adequate research equipment in the institutions without which what was studied abroad cannot optimally be applied to Bolivia, and an alienation phenomenon which renders the former trainees non adjustable to their country's realities, and generates much frustration.

Economic limitations seem to affect most research in areas such as those of the pure and natural sciences. They also affect the social sciences but, in addition, these latter often suffer from political harassment if not outright repression.

External assistance to research has come to Bolivia in three forms: scholarships for Bolivians to study abroad, technical assistance through resident advisers who do research and teach in the country, and donation of research equipment to the tra inee's institutions. Most money has traditionally gone to the first of these three formats and least to the third. Some Bolivians feel it would be very desirable to have a substantive increase in equipment endowement as a device to retain the graduates and optimize the use of what they have learned abroad. Others also wish that the foreign scholarship demand would have a closer fit to the country's prioritary needs. For others yet a main foreign input should now go to helping the country establish its own graduate training programs in those areas locally viable.

How have IDRC study grants been related, so far, to the Bolivian needs and problems here described? Of the few scholarships granted to this country, most have been for very short periods of training and least seem to have gone to strictly research purposes. This was so because one major training effort has been performed by the Information Sciences Division: Project SYFNID which is aimed to train documentalists. Two other IS projects - in industrial and geological information also included a few trainees. The quinoa project has been probably the only including graduate level training opportunities for a couple of researchers. Other projects, in health science and in social science, have only paid for short-term and non-degree training for a few individuals. Non-project scholarships have gone thus far mostly to persons in the information field.